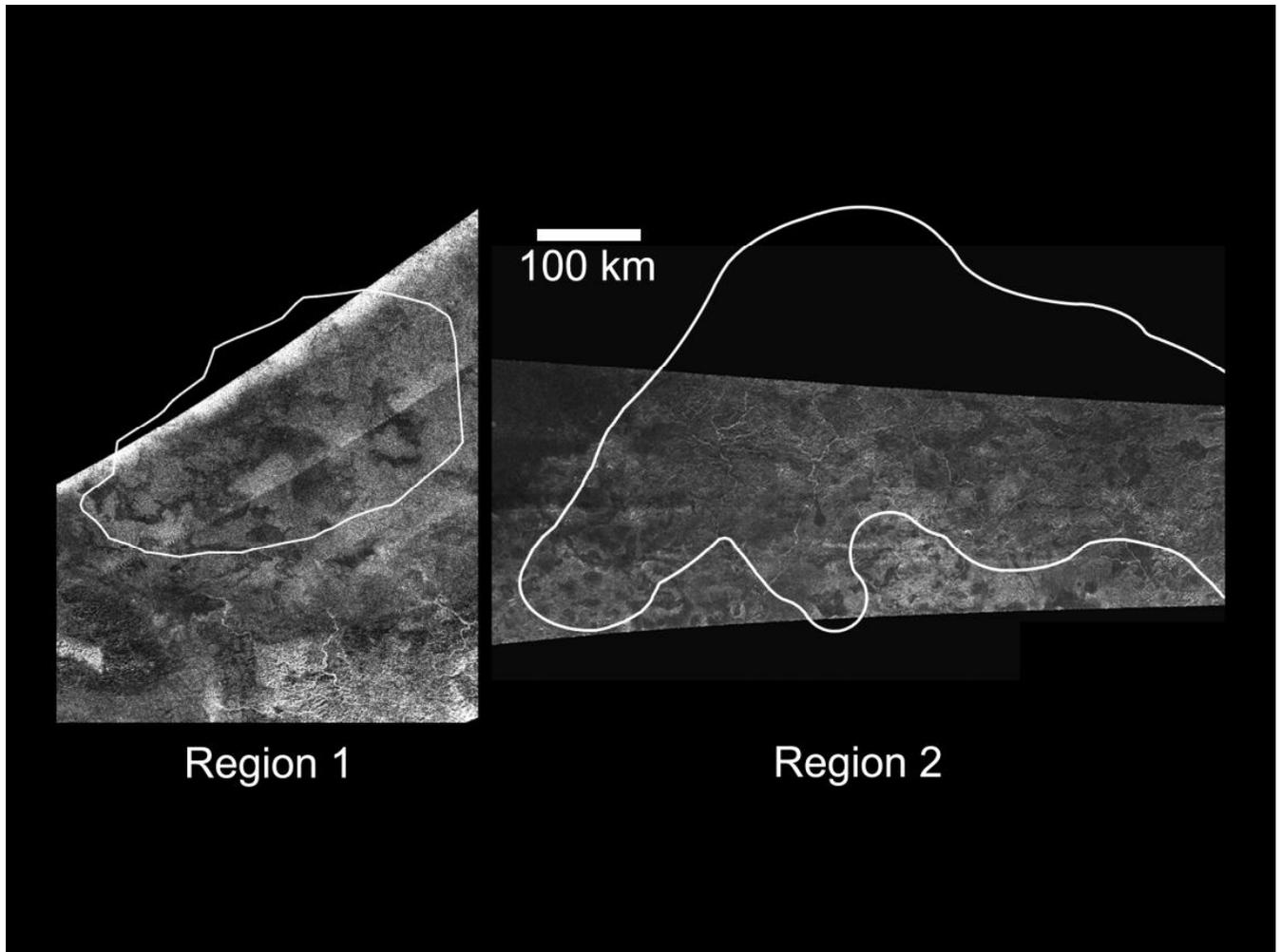


C A S S I N I



TITAN 102TI(T50) MISSION DESCRIPTION

February 7, 2009

Jet Propulsion Laboratory
California Institute of Technology

Cover image: [Active Cryovolcanic Features on Titan?](#) December 15, 2008

The Cassini Radar Mapper imaged Titan on Feb. 22, 2008 (as shown on the left) and April 30, 2006 (as shown on the right). These radar images show the outlines of regions "1" and "2" identified by Cassini's visual and infrared mapping spectrometer and inferred to be variable (see VIMS flat map, [PIA11701](#)), and which have been hypothesized to be due to cryovolcanic activity.

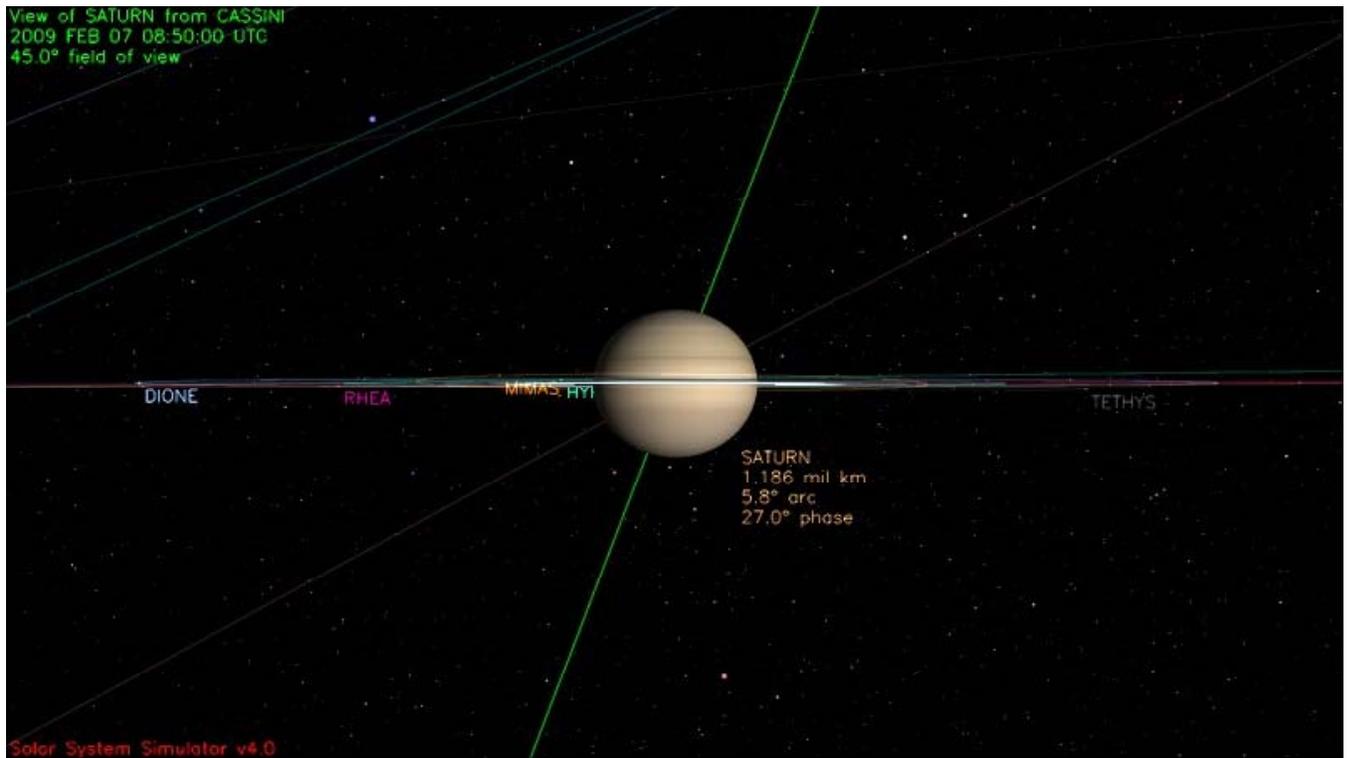
The lobate, flow-like features in region 1 are consistent with this interpretation. Region 1 is just north of the feature named Hotei Arcus and is centered on 28 degrees south latitude by 78 degrees west longitude.

The region is about 400 kilometers (249 miles) across. Region 2 is on the western part of Xanadu and is centered on 7 degrees south latitude by 135 degrees west longitude. This region is about 900 kilometers (560 miles) across. In both cases, north is up, and features as small as 300-500 meters can be resolved.

1.0 OVERVIEW

After a 48 day hiatus since its previous flyby, Cassini returns to Saturn's largest moon for the mission's fifty-first targeted encounter with Titan. The closest approach to Titan occurs on Saturday, February 7, at 2009-038T08:50:51 spacecraft time at an altitude of 960.0 kilometers (~600 miles) above the surface and at a speed of 6.3 kilometers per second (14,000 mph). The latitude at closest approach is 33.7 degrees S and the encounter occurs on orbit number 102.

This encounter is set up with two maneuvers: an apoapsis maneuver on January 23, and a Titan approach maneuver, scheduled for February 3. T50 is the fourteenth in a series of outbound encounters and the sixth Titan encounter in Cassini's Solstice Mission. It occurs just under five days after Saturn closest approach.



ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.1 TITAN-50 SCIENCE HIGHLIGHTS

- **INMS:** Closest approach at T50 features an INMS prime observation to measure the boundary between the wake side and inner flank magnetospheric interaction region at mid Southern latitudes.
- **RADAR:** The instrument rides along with INMS at closest approach. During the flyby, the instrument will collect SAR of the mountain ranges southwest of Tsegihi that were suggested in VIMS data. Altimetry inbound and outbound completes the instrument's plans.
- **CIRS:** On T50 CIRS focuses on mapping temperatures, trace hydrocarbons, nitriles and oxygen compounds in Titan's stratosphere. CIRS also continues to search for weak isotopes and new gas species.
- **VIMS:** During T50, VIMS will observe Titan from a large distance and will conduct cloud mapping. It will ride along with other instruments to probe Titan's atmosphere at the limb.
- **UVIS** will obtain an image cube of Titan's atmosphere at EUV and FUV wavelengths by sweeping its slit across the disk. These cubes provide spectral and spatial information on nitrogen emissions, H emission and absorption, absorption by simple hydrocarbons, and the scattering properties of haze aerosols. This is one of many such cubes gathered over the course of the mission to provide latitude and seasonal coverage of Titan's middle atmosphere and stratosphere.
- **ISS** will ride-along with VIMS to monitor clouds. (No illuminated prime observations.)
- **MIMI** measures energetic ion and electron energy input to Titan's atmosphere.
- **MAG:** T50 is an upstream flank-in flyby with a minimum altitude of 1000 kilometers. The geometry of this flyby is suitable to study the magnetic pileup region across the nightside hemisphere. T50 also takes place in Saturn's near-noon sector (10.5 hours SLT), where Titan could be found in the magnetosheath if the solar wind pressure is high.
- **RPWS** will measure thermal plasmas in Titan's ionosphere and surrounding environment; search for lightning in Titan's atmosphere; and investigate the interaction

of Titan with Saturn's magnetosphere.

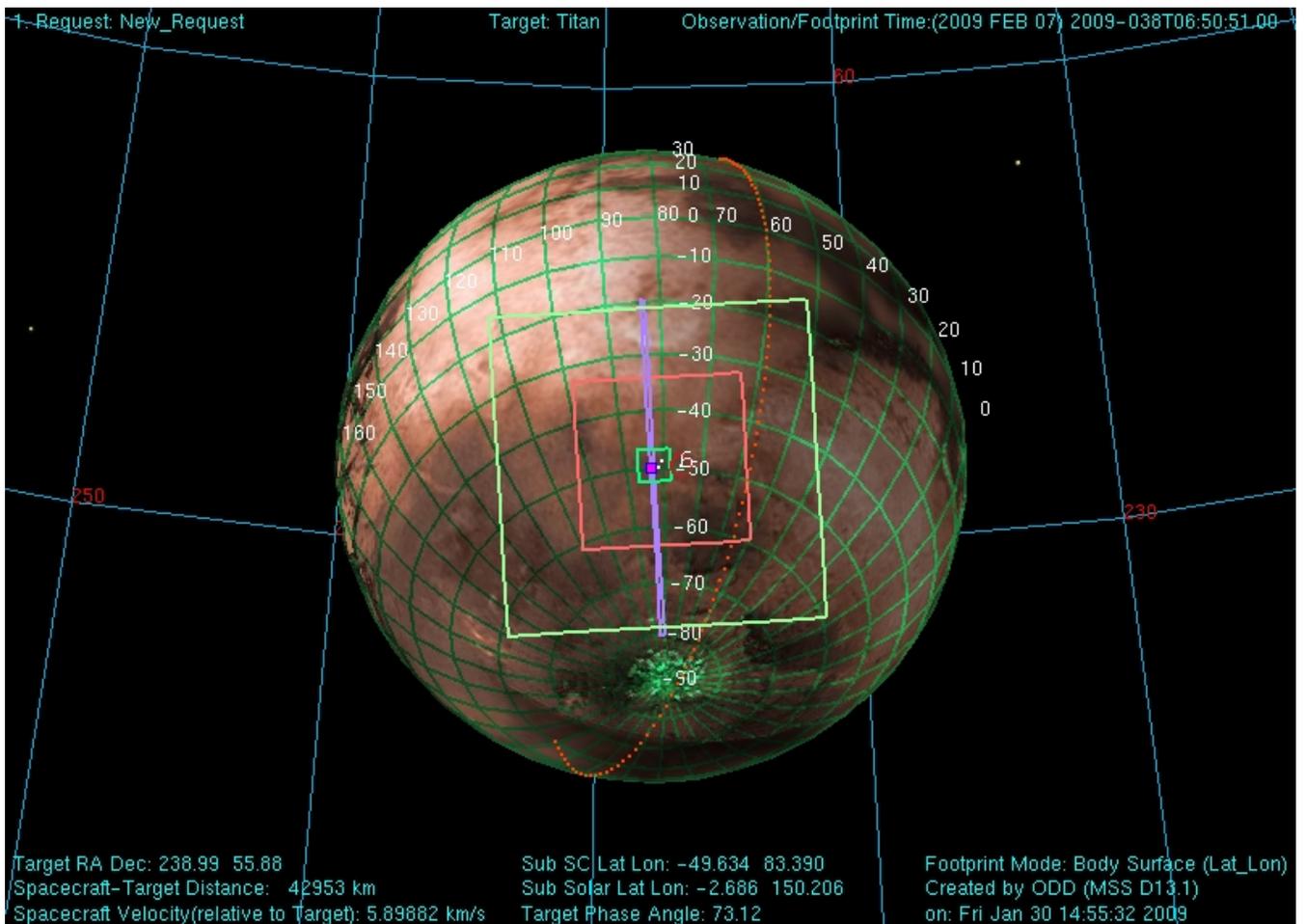
SAMPLE SNAPSHOTS

Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

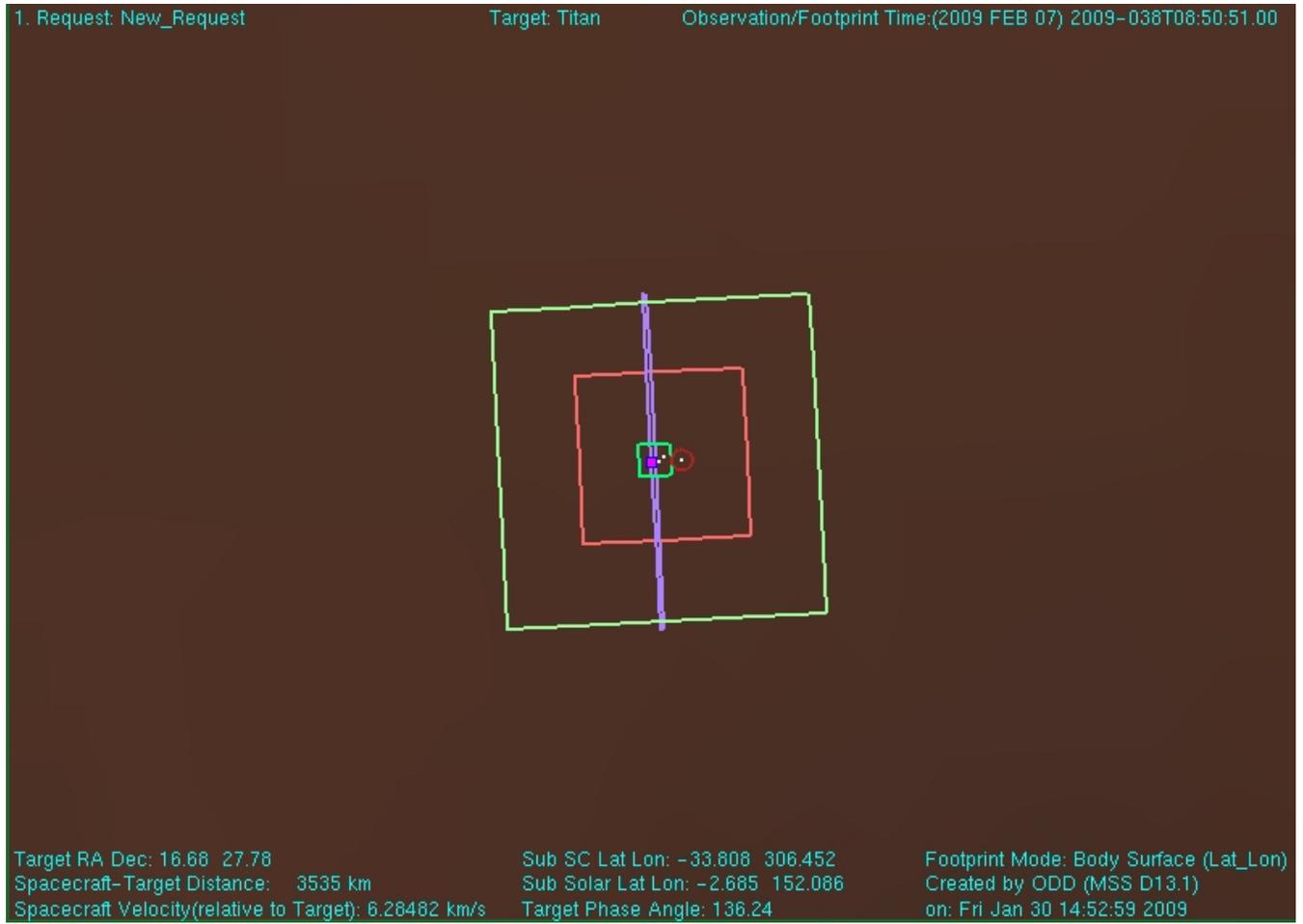
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

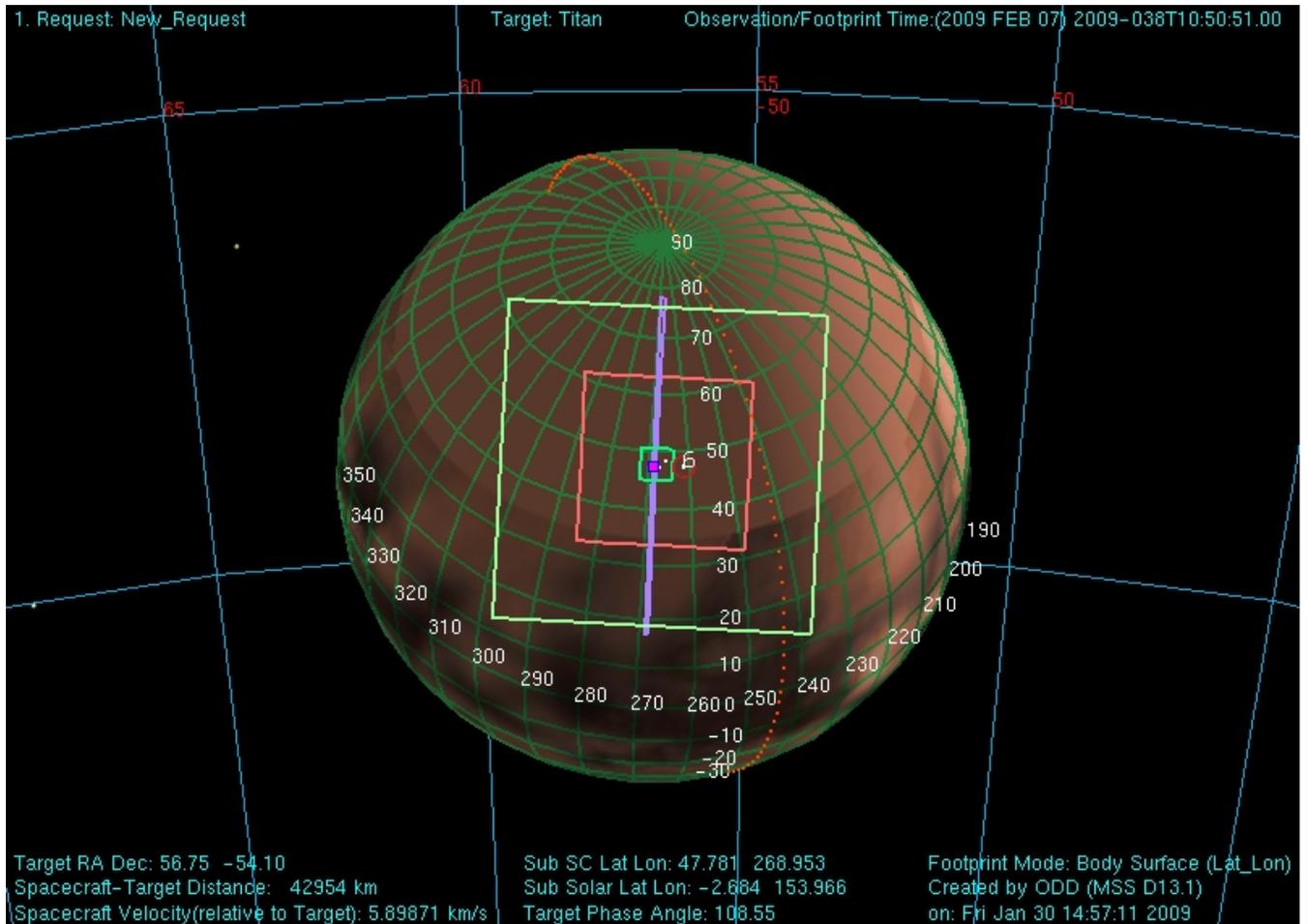
View of Titan from Cassini two hours before Titan-50 closest approach



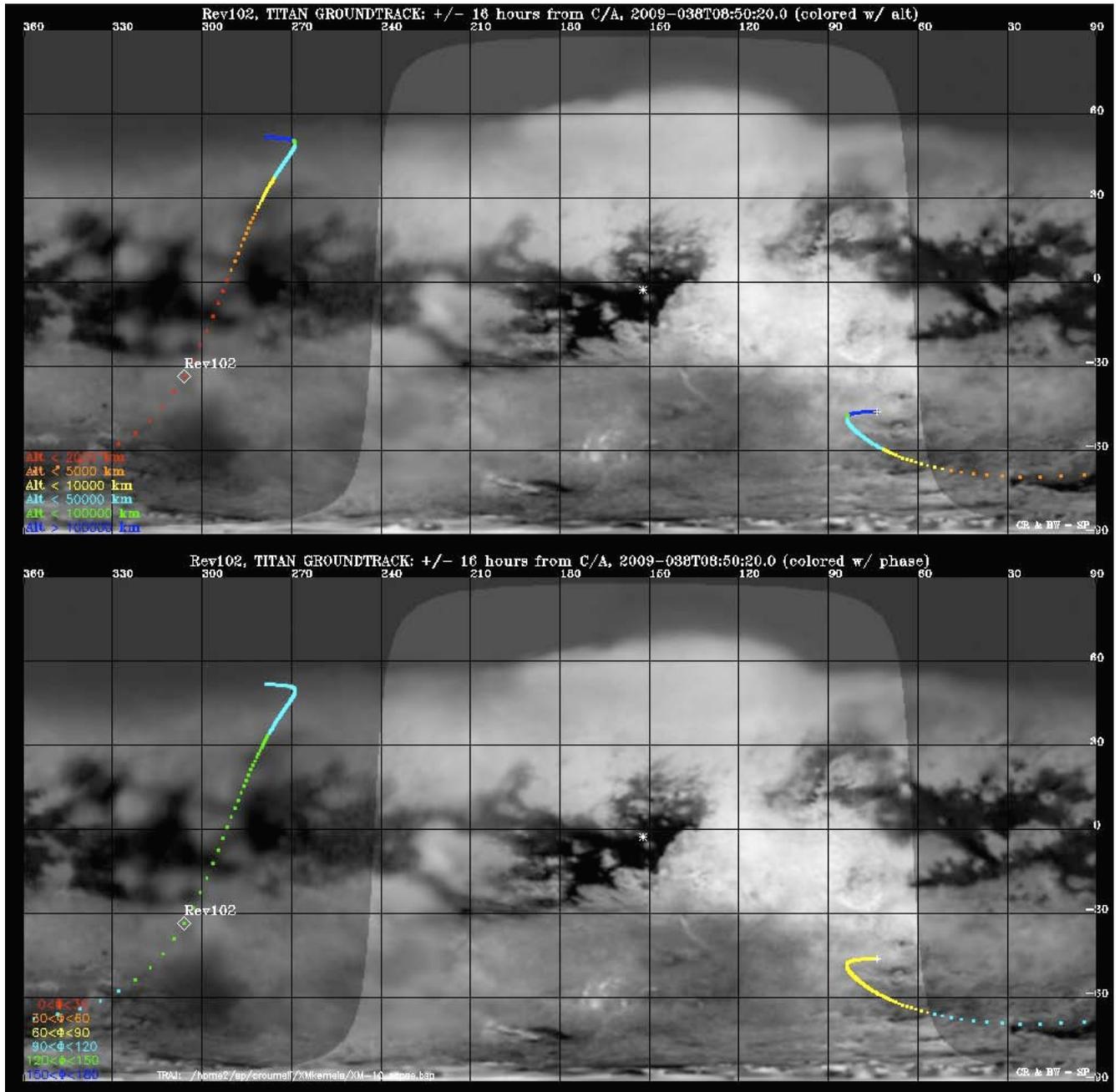
View of Titan from Cassini at Titan-50 closest approach



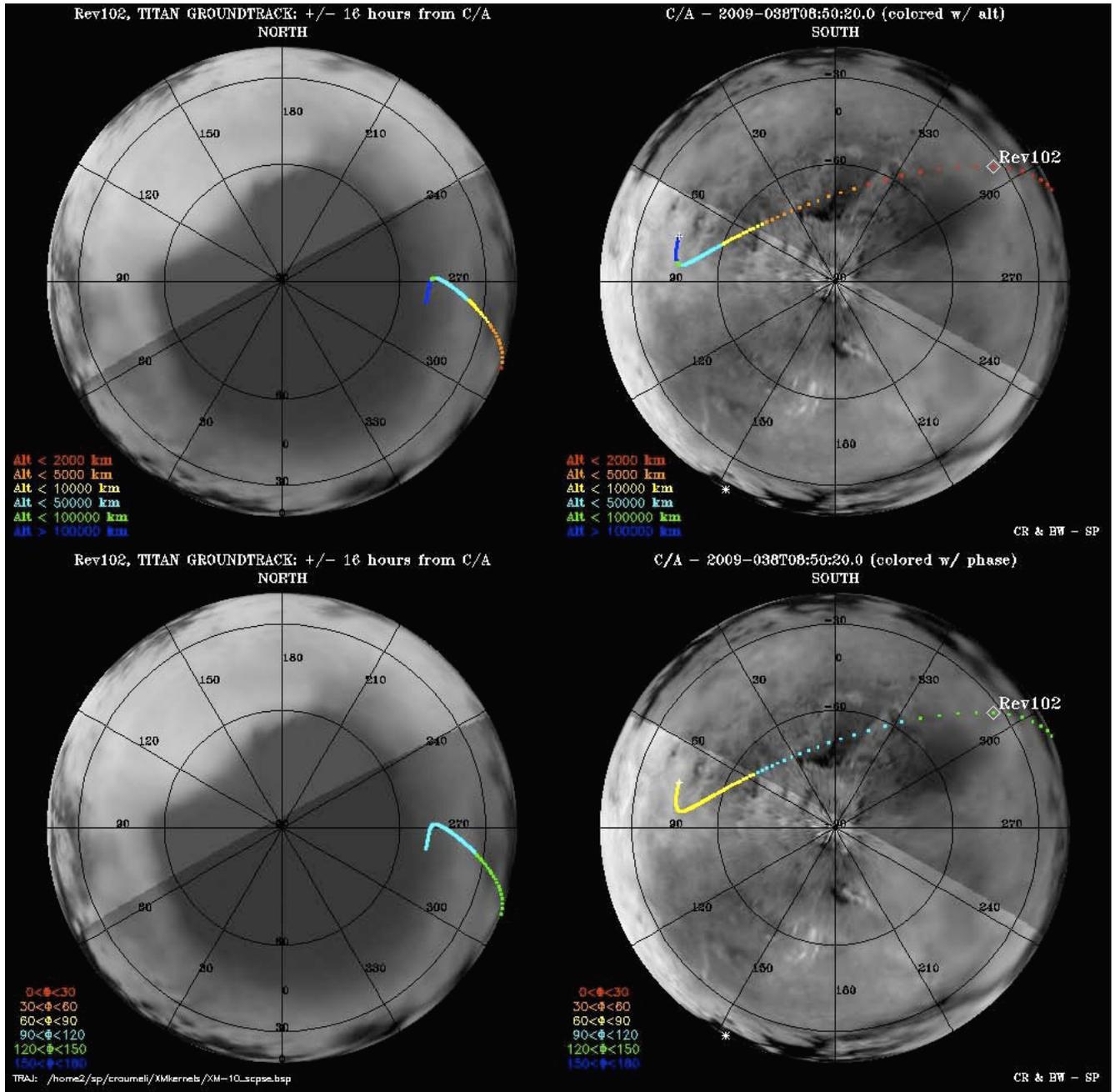
View of Titan from Cassini two hours after Titan-50 closest approach



Titan Groundtracks for T50: Global Plot



Titan Groundtracks for T50: Polar Plot



The T50 timeline is as follows:

Cassini Titan-50 Timeline - February 2009

Colors: yellow = maneuvers; blue = geometry; pink = T50-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T50	Activity	Description
009T15:16:00	Jan 09 16:32	Fri Jan 09 08:32 AM	T50-28d18h	Start of Sequence S47	Start of Sequence which contains Titan-50
035T04:34:00	Feb 04 05:50	Tue Feb 03 09:50 PM	T50-03d04h	OTM #181 Prime	Titan-50 targeting maneuver.
036T04:19:00	Feb 05 05:35	Wed Feb 04 09:35 PM	T50-02d05h	OTM #181 Backup	
037T13:19:00	Feb 06 14:35	Fri Feb 06 06:35 AM	T50-19h31m	Start of the TOST segment	
037T13:19:00	Feb 06 14:35	Fri Feb 06 06:35 AM	T50-19h31m	Turn cameras to Titan	
037T13:59:00	Feb 06 15:15	Fri Feb 06 07:15 AM	T50-18h51m	New waypoint	
037T13:59:00	Feb 06 15:15	Fri Feb 06 07:15 AM	T50-18h51m	Deadtime	15 minutes long; used to accommodate changes in flyby time
037T14:14:31	Feb 06 15:30	Fri Feb 06 07:30 AM	T50-18h36m	Cloud and global mapping - VIMS	Stare at Titan for cloud and global mapping.
037T19:50:51	Feb 06 21:06	Fri Feb 06 01:06 PM	T50-13h00m	Titan atmospheric observations-CIRS	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
037T23:20:51	Feb 07 00:36	Fri Feb 06 04:36 PM	T50-09h30m	Titan atmospheric observations-CIRS	Obtain vertical profiles of temperatures in Titan's stratosphere.
038T03:20:51	Feb 07 04:36	Fri Feb 06 08:36 PM	T50-05h30m	Titan RADAR Observations	Inbound Radiometry
038T06:50:51	Feb 07 08:06	Sat Feb 07 12:06 AM	T50-02h00m	Titan RADAR Observations	Inbound Scatterometry
038T07:38:51	Feb 07 08:54	Sat Feb 07 12:54 AM	T50-01h12m	Transition to thruster control	
038T07:39:51	Feb 07 08:55	Sat Feb 07 12:55 AM	T50-01h11m	Titan RADAR Observations	Inbound HiSAR
038T08:20:51	Feb 07 09:36	Sat Feb 07 01:36 AM	T50-00h30m	Titan RADAR Observations	Inbound Altimetry
038T08:38:51	Feb 07 09:54	Sat Feb 07 01:54 AM	T50-00h12m	Atmospheric Observations-INMS	INMS with RADAR ride-along SAR at closest approach
038T08:48:25	Feb 07 10:04	Sat Feb 07 02:04 AM	T50-00h02m	Earth Occultation	10 minute duration
038T08:48:	Feb 07 10:04	Sat Feb 07 02:04 AM	T50-00h02m	Sun Occultation	9 minute duration
038T08:50:51	Feb 07 10:06	Sat Feb 07 02:06 AM	T50+00h00m	Titan-50 Flyby Closest Approach Time	Altitude = 960 km (~600 miles), speed = 6.3 km/s (14,000 mph); 136 deg phase at closest approach
039T02:29:27	Feb 08 03:45	Sat Feb 07 07:45 PM	T50+17h39m	Apoapse	
038T09:02:51	Feb 07 10:18	Sat Feb 07 02:18 AM	T50+00h12m	Titan RADAR Observations	Outbound Altimetry
038T09:20:51	Feb 07 10:36	Sat Feb 07 02:36 AM	T50+00h30m	Titan RADAR Observations	Outbound HiSAR
038T09:40:51	Feb 07 10:56	Sat Feb 07 02:56 AM	T50+00h50m	Transition off of thruster control	
038T10:02:32	Feb 07 11:18	Sat Feb 07 03:18 AM	T50+01h12m	Titan RADAR Observations	Outbound Scatterometry
038T10:50:51	Feb 07 12:06	Sat Feb 07 04:06 AM	T50+02h00m	Titan RADAR Observations	Outbound Radiometry
038T09:19:58	Feb 07 10:35	Sat Feb 07 02:35 AM	T50+00h29m	Ascending Ring Plane Crossing	
038T14:50:51	Feb 07 16:06	Sat Feb 07 08:06 AM	T50+06h00m	Titan atmospheric observations-UVIS	EUVFUV: Several slow scans across Titan's visible hemisphere to form spectral images
038T17:50:51	Feb 07 19:06	Sat Feb 07 11:06 AM	T50+09h00m	Titan surface observations-ISS	monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
038T18:50:51	Feb 07 20:06	Sat Feb 07 12:06 PM	T50+10h00m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
038T21:50:51	Feb 07 23:06	Sat Feb 07 03:06 PM	T50+13h00m	Titan surface observations-ISS	Monitoring for surface/atmosphere changes; attempt to see surface color variations; monitor limb hazes, 1-3 km/px
038T22:20:51	Feb 07 23:36	Sat Feb 07 03:36 PM	T50+13h30m	Titan atmospheric observations-CIRS	Obtain information on the thermal structure of Titan's stratosphere.
039T02:50:51	Feb 08 04:06	Sat Feb 07 08:06 PM	T50+18h00m	Titan surface observations-ISS	Long range monitoring
039T03:20:51	Feb 08 04:36	Sat Feb 07 08:36 PM	T50+18h30m	Deadtime	18 minutes 08 seconds long; used to accommodate changes in flyby time
039T03:39:00	Feb 08 04:55	Sat Feb 07 08:55 PM	T50+18h49m	Turn to Earth-line	